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TEST CODE FOR PUDDLER

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Indian Standard
TEST CODE FOR PUDDLER

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Indian Standard

TEST CODE FOR PUDDLER

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 24 December 1985, after the draft finalized by the Soil Working Equipment Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 Puddling is the process of manipulation of soil in presence of standing water to reduce percolation rate and weed. This facilitates transplanting of seedlings.

0.3 The puddler is an implement specially designed for quick and efficient working of the soil for the preparation of paddy fields with standing water after initial ploughing. Performance evaluation of the puddlers comprises the assessment of quality and quantity of work done by them. This test code has been prepared to facilitate the performance evaluation of the puddler.

1. SCOPE

1.1 This standard prescribes the guidelines for checking the specifications, field testing and performance evaluation of different types of puddlers, such as helical blade type, rotary blade type and paddle type. The puddlers may be of animal-drawn or tractor operated.

2. TERMINOLOGY

2.0 For the purpose of this standard the following definitions shall apply.

2.1 Puddling — The mechanical manipulation of soil in presence of standing water in the field to create a least pervious layer that prevents the loss of water through percolation and facilitate the transplanting of paddy seedlings by making the soil softer.

2.2 Field Capacity

2.2.1 *Theoretical Field Capacity* — It is the rate of field coverage that would be obtained if the machine were performing its function

100 percent of the time at the rated speed and always covering 100 percent of its rated width. It is given by the formula

$$\text{Theoretical field capacity, ha/h} = \frac{S \times W}{10\,000}$$

where

S = speed of travel, kmph; and
W = rated width of implement, mm.

2.2.2 *Effective Field Capacity* — It is the actual average rate of coverage by the machine. Effective field capacity is expressed by the formula:

$$\text{Effective field capacity, ha/h} = \frac{S \times W \times E_f}{10^6}$$

where

S = speed of travel, kmph;
W = rated width of implement, mm; and
E_f = field efficiency, percent.

2.2.3 *Field Efficiency* — It is the ratio of effective field capacity to the theoretical field capacity and is expressed in percent.

2.3 Puddling Index — It is the ratio between volume of settled soil and total volume of sample and it is given by the formula:

$$\text{Puddling Index} = \frac{V_s}{V} \times 100$$

where

V_s = volume of settled soil, and
V = total volume of sample.

2.4 Bulk Density — It is the mass of the soil per unit volume. This is also known as the apparent density. If the density of soil is high, it is said to be more compact. Bulk density shall be calculated on dry basis. The bulk density is given by the formula:

$$D = \frac{M}{V}$$

where

D = bulk density,
M = mass of soil, and
V = total volume of composite soil.

2.5 Percolation — Percolation is the downward movement of water through saturated or nearly saturated soil in response to the force of gravity.

2.6 Infiltration — The movement of water from the surface into the soil is called infiltration. Infiltration rate is the rate at which water can enter the soil under specific condition, including the presence of excess water.

3. SELECTION OF SAMPLE FOR TEST

3.1 Selection of Sample — The puddler shall be selected at random from the series production by the representative of the testing station with the consent of the manufacturer. It would be the responsibility of the manufacturer to ascertain that the puddler selected for testing is complete in all respects and necessary adjustments have been carried out in the presence of the representative of the testing authority.

3.2 Specifications and other Literature — The manufacturer shall supply the operator's manual, instruction manual and detailed drawing showing all the components of puddler. The manufacturer shall also supply a specification sheet duly filled in as given in Appendix A. Any other information required for conducting the test shall also be supplied by the manufacturer.

4. SELECTION OF TEST PLOT AND PREPARATION OF SAMPLE FOR FIELD TEST

4.1 Selection of Test Plot

4.1.1 The minimum area of the plot for testing of animal drawn puddler shall be 0·25 hectare and for tractor-operated puddlers, one hectare. The ratio of width and length of the plot shall be as far as possible 1 : 2. The plot selected for puddling shall be given a uniform tillage operation. The surface shall be reasonably levelled and slope shall not exceed 1 percent. Minimum 5 to 10 cm of water column shall be maintained in the test plot. The conditions of the test plot shall be reported as given in **4.1.2**.

4.1.2 The following conditions of the plot shall be checked before watering the plot for puddling recorded.

a) Location of the test plot;

b) Size of the plot;

c) Type of soil and soil *p*H;

d) Last crop grown;

e) Details of the tillage operations, if any, after the harvest of last crop;

f) Soil moisture percentage;
g) Type of weed and weed intensity; and
h) Topography.

4.1.2.1 After watering the plot for puddling, following measurements shall be taken before puddling:

a) Height of standing water above ground surface,
b) Bulk density at various places, and
c) Infiltration rate (steady state).

4.2 Preparation of the Sample

4.2.1 The testing authority shall ensure that the puddler has been properly assembled and lubricated.

4.2.2 All the attachments and accessories required for field use shall be fitted in place and the adjustments made shall be in accordance with the manufacturer's recommendations (*see* **3.1**).

4.2.3 The puddler shall be properly hitched with the source of power. In case of tractor-operated puddlers, as far as possible, the same horse power range of tractor shall be used for testing as specified by the manufacturer.

4.2.4 In case of tractor-operated puddler, the gear selected during the test shall be the fastest gear in which satisfactory and safe operation is achieved. The limiting factor for further increase of forward speed shall be specified by the manufacturer. The gear selected at the start of the test shall not be changed throughout the test. Throttle setting shall be such that at the selected forward speed, the engine develops adequate power with some reserve for temporary overloads and there is maximum fuel economy. The initial throttle setting shall not be disturbed during the test except for turning at head lands and to take care of field exigencies.

5. TESTS

5.0 The tests given in **5.1** and **5.2** shall be carried out in the laboratory and in the field respectively.

5.1 Laboratory Tests — The following tests shall be conducted in the laboratory.

5.1.1 *Checking of Specification* — The specification supplied by the manufacturer as given in Appendix A shall be checked and reported.

5.1.2 *Chemical Composition of Soil Engaging Parts* — The material of soil engaging parts of the puddler shall be analysed for the chemical composition and reported.

5.1.3 *Visual Observations* — The observation given in Appendix B shall be assessed visually and reported.

5.2 Field Test

5.2.0 *Short-Run Tests* — At least five series of field tests each covering the minimum area as mentioned in **4.1.1** shall be carried out. Depending upon the facilities available, additional series of field tests may be conducted.

5.2.1 Field conditions as mentioned in **4.1.2** shall be recorded in Table 1 before puddling.

5.2.2.1 After watering the test plot for puddling, the following parameters shall be checked before puddling and the observations shall be recorded in Table 1.

TABLE 1 FIELD OBSERVATION BEFORE PUDDLING

Location of the Test Plot	Size of Plot	Type of Soil	Last Crop Grown	Tillage Operation, if any, after Harvest	Soil Moisture (Percent) (Average of 10 Readings)	Type of Weed and Weed Intensity	Topography of the Field	Height of Standing Water Above Ground Surface	Bulk Density (Average of 10 Readings)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

5.2.2.1 Height of standing water above ground surface.

5.2.2.2 *Bulk density* (*see* **2.4**) — The soil sample from the field shall be collected by standard soil sampling method and dried in oven at 105°C for 24 h and the bulk density shall be calculated on dry basis.

5.2.2.3 *Infiltration* — Infiltration shall be determined by ponding water in metal cylinder installed on the field surface and observing the rate at which water level is lowered in the cylinder. The lateral movement of water from cylinders shall be minimized by ponding water in a guard cylinder of buffer area around the cylinder. The cylinder shall be formed of 2 mm rolled steel. The inner cylinder from which the infiltration measurement is taken shall be 30 cm in diameter and 45 cm long, open at both ends. The outer cylinder, which is used to form the buffer pond shall be of 60 cm in diameter. The cylinders shall be installed about 15 cm deep in the soil The water level in the inner cylinder shall be read with a field type point gauge or hook gauge. The point gauge measurements shall be made at frequent intervals to determine the amount of water that has infiltrated during the time interval.

5.2.3 *Quality of Work* — The puddler shall be set at the proper working depth as indicated by the manufacturer, at lowest hydraulic position (in case of tractor-operated puddlers), and without extra mass. Then the puddler shall be operated as per the recommendations of the manufacturer and the following observations shall be made and recorded in Table 2.

5.2.3.1 *Depth of puddling* — A special probe of 25·4 mm diameter and 1 000 mm long, graduated in millimetres shall be used to measure the depth of puddling by penetrating it vertically into the puddle. The depth at which the force required to push the rod manually into the puddle, increases by 2 kg shall be taken as the depth of puddle.

5.2.3.2 *Puddling index* — For determining the puddling index the samples of soil-water suspension shall be taken by immersing a glass tube to a depth of about 100 millimetres. The samples shall be taken from a number of points and shall be collected in measuring cylinders. These shall be kept undisturbed for 48 hours to allow the soil to settle. The volume of settled soil shall be noted for computing the puddling index (*see* 2.3).

5.2.3.3 *Bulk density* — *See* **5.2.2.2.**

5.2.3.4 *Infiltration* — *See* **5.2.2.3.**

5.2.3.5 *Height of standing water over puddled field* — shall be measured accurately with a steel tape/wooden scale.

5.2.4 *Power Requirement*

TABLE 2 FIELD OBSERVATION DURING PUDDLING TEST

(*Clause* 5.2.3)

Date of Test	Type of Puddler	Type of Prime-Mover	Name of Test Engineer	Time of Start of Test (h)	Stoppage, if any, During Test (h)
(1)	(2)	(3)	(4)	(5)	(6)

Time of Finish of Test (h)	Speed of Prime Mover rev/min		Travel Time for 10/20 m Distance	Draft (kgf)		No. of Runs Made to Obtain the Desired Puddling
	No Load	Load		No Load	Load	
(7)	(8)	(9)	(10)	(11)	(12)	(13)

Depth of Water Over Puddle (cm) (Average of 10 Readings to be Measured After 24 h)	Depth of Puddle (cm) (Average of 10 Readings to be Measured After 24 h)	Puddling from the Samples Collected of At Least 10 Points	Bulk Density (Average of 10 Readings)	Percentage of Weed Killed/Burried (to be Measured from the Readings of At Least 10 Points
(14)	(15)	(16)	(17)	(18)

Area Covered in Hectare	Fuel Consumption, Litre (if Power Operated)	Infiltration cm
(19)	(20)	(21)

5.2.4.1 *For trailed tractor-drawn and animal-drawn puddlers*

a) Lay off a length of 30 m in the middle of a long row and mark each end of this space with an easily identifiable pole.

b) Insert a direct-reading spring or hydraulic dynamometer in the hitch to measure the draft in kgf. The draft is defined as the horizontal, component of the pull, parallel to the line of motion. If the line of pull through the dynamometer is not horizontal, measure the angle between the line of pull and the horizontal and calculate the horizontal component (draft) by the following formula :

$$D = P \cos \theta$$

where

D = draft in kgf,
P = pull in kgf, and
θ = angle between the line of pull and the horizontal.

c) Start the puddler well before the first pole marker and ensure that it operates uniformly when it reaches the pole. As the puddler is operated for 30 m length, record 10 or more readings of the dynamometer. Calculate the average of these readings for obtaining the average draft for the 30 m run. A stop-watch or other accurate time piece shall be used to record the time taken by the puddler to traverse the 30 m. Calculate the speed of travel in metre per second from this value.

d) Calculate the drawbar horse power from the following formula :

$$\text{Drawbar horse power} = \frac{\text{Draft in kgf} \times \text{Speed in metre per second}}{75}$$

5.2.4.2 *For mounted tractor-drawn puddler*

a) Lay off a length of 30 m in the middle of a long row and mark each end of this space with an easily identifiable pole.

b) A direct reading spring or hydraulic type dynamometer shall be attached in front of the tractor. Another tractor shall be used to pull the tractor to which the puddler is attached.

c) Repeat the operation as in **5.2.4.1**(c).

d) Detach the puddler from the tractor and record the draft required only to pull the tractor (with which puddler is attached) in the same manner as in **5.2.4.2**(c). Ensure that the tractor is pulled at the same speed as in the case of **5.2.4.1**(c).

e) Obtain the draft of the puddler by deducting the draft of the tractor as obtained in **5.2.4.2(d)** from the draft of the puddler and the tractor as obtained in **5.2.4.2**(c).

f) Calculate the drawbar horse power in accordance with the procedure given in **5.2.4.1**(d).

NOTE — In case the facility for strain gauge dynamometer is available for direct reading of the draft, the same shall be used and the methods stipulated under **5.2.4.2**(b), (d) and (e) shall be overlooked.

5.2.4.3 Record the observations as given in Table 3.

TABLE 3 POWER REQUIREMENT

DATE OF TEST (1)	ROTARY BLADE ANGLE (2)	TEST NO. (3)	TIME SPENT TO COVER 30 m RUN (SECONDS) (4)	SPEED m/s (5)

DRAFT OF PUDDLER AND TRACTOR (kgf) (6)	DRAFT OF TRACTOR (kgf) (7)	DRAFT OF PUDDLER (kgf) (8)	DRAWBAR HORSE POWER (hp) (9)

5.2.5 *Fuel Consumption*

5.2.5.1 The fuel consumption for power-operated puddlers shall be checked in the test plot and the observations shall be recorded as given in Table 4.

5.2.6 *Rate of Work*

5.2.6.1 *Effective field capacity or output* — The puddler shall be operated for continuous field work for at least 4 hours and the area covered during the period shall be measured in hectares. Calculate the area covered in hectare per hour from the net duration of test (total duration stoppage, if any).

TABLE 4 FUEL CONSUMPTION TEST FOR POWER-OPERATED PUDDLERS

(*Clause* 5.2.5.1)

TYPE OF PUDDLER (1)	NAME OF THE POWER SOURCE (2)	POWER RATING (hp) (3)	FUEL TANK CAPACITY (l) (4)	CUMULATIVE FUEL CONSUMED DURING TEST (l) (5)	CUMULATIVE AREA COVERED DURING TEST (ha) (6)	FUEL CONSUMPTION PER HOUR (l) (7)	FUEL CONSUMPTION PER HECTARE (l) (8)	REMARKS (9)

5.2.6.2 *Theoretical field capacity* — On the basis of the theoretical width of puddling and speed, calculate the theoretical field capacity by the following formula:

$$\text{Theoretical field capacity in hectare/h} = \frac{\text{Theoretical width (mm)} \times \text{Speed (km/h)}}{10\,000}$$

5.2.6.3 *Field efficiency* — Calculate the field efficiency as follows:

$$\text{Field efficiency, percent} = \frac{\text{Effective field capacity}}{\text{Theoretical field capacity}} \times 100$$

5.2.6.4 Record the observations as given in Table 5.

TABLE 5 FIELD EFFICIENCY

(*Clause* 5.2.6.4)

DATE OF TEST (1)	ROTARY BLADE ANGLE (2)	STARTING TIME (3)	FINISHING TIME (4)	TOTAL TIME SPENT (5)	IDLE PERIOD (6)

NET WORKING TIME (7)	AREA COVERED (8)	EFFECTIVE FIELD CAPACITY (9)	THEORETICAL FIELD CAPACITY (10)	FIELD EFFICIENCY (11)

5.2.7 *Ease of Operation and Adjustments* — Assess and record the observations regarding ease of operation and adjustment during the test.

5.2.8 *Soundness of Construction* — Check the deformation and breakage of parts, if any, during the test. All the defects, breakdowns and modification made during the test shall be reported.

5.2.9 Repeat the above tests at the average and maximum depth of operation for every test conducted and record the observations. Also record the following visual observations.

5.2.9.1 *Other Visual Observations*

a) *Machine Aspects*

1) Ease of handling
2) Adjustment and precision
3) Maintenance and repairs
4) Safety
5) Breakdowns
6) Type of bearings used

- b) *Field Operational Aspects*
    - 1) Man-hour requirement/ha
    - 2) Field efficiency
    - 3) Fuel consumption, 1/ha

5.3 Long-Run Test — The puddler shall be operated for at least 50 h exclusive of the period covered under short-run tests (*see* **5.2**). If possible, it may be run for 200 h. The major breakdown, defects developed and repairs made during this period shall be reported

6. SUMMARY REPORT

6.1 For reducing the data to a usable form, prepare a summary report.

APPENDIX A

(*Clauses* 3.2 *and* 5.1.1)

SPECIFICATIONS OF PUDDLER—SHEET A

A-1. GENERAL

- a) Name of the implement
    - 1) Local name
- b) Model and serial number
- c) Year of manufacture
- d) Name and address of manufacturer

A-2. SOURCE OF POWER

- a) Animal
- b) Tractor
    - 1) Make and model
    - 2) hp range

A-3. OVERALL DIMENSIONS

- a) Length, mm
- b) Width, mm
- c) Height, mm
- d) Weight, kg

A-4. DETAILS OF COMPONENTS

a) Type

b) Dimensions :

  1) Length, mm
  2) Width (working), mm
  3) Height, mm

c) Material of construction
d) Hardness (Rockwell/Brinell)
e) Type of mounting
f) Type of rotor shaft bearings
g) Other details, if any

A-5. DETAILS OF SOIL ENGAGING PART OR ROTOR

a) Type of blade
b) No. of blades
c) Size of blades
d) Width of blades
e) Angle of blade with axis
f) Type of shaft

  1) Hollow or solid
  2) Square or round

g) Method of fitting of shaft on frame

h) Method of fixing the blades on shaft

j) Edge of the blade

  1) Plain
  2) Serrated

k) Working width of rotary blade, mm
m) Diameter of rotor, mm
n) Diameter of shaft, mm
p) Maximum height of blade from shaft on frame
q) Distance between two blades on shaft
r) Arrangement of blades

A-6. DETAILS OF THE FRAME

a) Material of construction
b) Size of frame

A-7. GROUND WHEEL/TRANSPORT WHEEL

a) Diameter of wheel, mm
b) Width, mm
c) No. of spokes,
d) Diameter of spoke, mm
e) Length of spoke, mm
f) Type of hub/bearing/bushing
g) Material of construction
h) Ground clearance, mm

A-8. CAGE WHEEL

a) Type
b) Diameter of cage wheel, mm
c) Width, mm
d) Angle of lugs, degree

A-9. SEAT

a) Type (removable or fixed type)
b) Constructional details
c) Dimensions of major components
d) Material of construction

A-10. BEAM

a) Dimensions
b) Arrangement for fixing yoke
c) Adjustment for hitch at yoke
d) Nature of fixing beam to body
e) Provision of angle adjustment of beam
f) Type of the mechanism of angle adjustment
g) Dimensions

A-11. HANDLE

a) Constructional details

b) Height of handle from ground level

c) Details of adjustments

A-12. PLANKER

a) Dimensions

b) Type

A-13. TOTAL WEIGHT (kg)

A-14. OTHER DETAILS, IF ANY

NOTE 1 — Technical drawing of puddler shall be attached.

NOTE 2 — The items not applicable to a particular puddler shall be struck off while filling the specification sheet.

NOTE 3 — Conformity or otherwise of a component with relevant Indian Standard shall be mentioned.

A-15. WEAR ASPECTS

SPECIFICATION OF PUDDLER—SHEET B

Additional specification for power-operated puddlers.

1. a) Type of power unit
   b) Model and serial number
   c) Year of manufacture
   d) Address of manufacturer
   e) Power (hp)
   f) Speed (rev/min) : No load speed at rated power
   g) Type of lubrication system : Splash/force feed
   h) Recommended lubricant and capacity
   j) Fuel tank capacity, l
   k) Weight of the engine, kgf
   m) Weight of power unit, kgf

2. **Support wheels**

   a) Number, type and size

b) Recommended tyre pressure
  1) For field operation
  2) For road
c) Track width (fixed)

3. Details of power transmission system (from engine to soil engaging parts a line diagram may be given).

APPENDIX B

(*Clause* 5.1.2)

DATA SHEET FOR VISUAL OBSERVATIONS

B-1. OBSERVATIONS

a) Tightness of bolts and nuts and other factors
b) Adequacy of lubrication of moving parts
c) Provision for transportation
d) Provision for easy change of components
e) Adequacy of arrangement to take care of side thrust
f) Provision for extra load platform and its placement
g) Provision for attachment of rotary blade
h) Provision for proper hitching arrangement to any type of source of power
j) Condition of bearings after the field test (presence of dust or water, if any)

B-2. ADJUSTMENT

a) Provision for rotary blade adjustment
b) Provision for hitch adjustment
c) Provision for depth adjustment

Test Engineer